Before the
Federal Communications Commission
Washington, D.C. 20554

NextNav Inc. Petition for Rulemaking	)	WT Docket No. 24-240
to Reconfigure the Lower 900 MHz Band	)	RM-11989

Comment in Opposition
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September 5, 2024

Executive Summary

Digi International Inc. (Digi) provides a wide range of customers including to governments, critical industries and consumers, with Part 15 unlicensed radios that are often incorporated into devices that provide remote sensing, monitoring, data collection and numerous other applications and functions as detailed in this Comment. The Lower 900 MHz band is home to hundreds of millions of these radios manufactured by Digi and competing providers and unlicensed radio customers have benefitted from the FCC's long-established hierarchy of spectrum rights in the band.

As the deployment of IoT devices continues at an ever-increasing pace, the Lower 900 MHz band is experiencing a surge in popularity for several key reasons. The first is increased penetration, especially for indoor networks, as 900 MHz allows communications to reliably penetrate walls, floors, door and other objects. Propagation is an additional characteristic making the sub-GHz band very desirable as is available power levels. The current rules for 900 MHz allow for the use of higher power radios. This combination of features makes the Lower 900 MHz spectrum a very popular home for the many millions of devices employed by critical industries. Further, as end users experience crowding in the 2.4 GHz band with elevated noise floors and decreased link budgets, Digi's customers are expressing an increasing desire to move their operations to 900 MHz spectrum. Simply put, 900 MHz spectrum offers users highly reliable communications links under difficult environmental conditions. That is not easily replicated elsewhere.

NextNav's Petition for Rulemaking seeks to have the FCC undertake a reconfiguration of the Lower 900 MHz band so that it can deploy a terrestrial PNT network by the creation of a single 15 MHz nationwide license, repacking other users from the current 26 MHz into the remaining 11 MHz. NextNav also seeks to eliminate the rule requiring pre-deployment testing of its operations to address the potential for interference from M-LMS to unlicensed radios and devices.

NextNav has failed to show that its desired 900 MHz reconfiguration is remotely required for the federal government to have viable future alternatives to GPS or for cellular operators to provide E911 location functionality. It has not seriously explored deployment in other bands where the effects on others might be more limited. NextNav also failed to show that its proposal would not result in catastrophic disruption, impose enormous costs on and degrade equipment performance of other users of the 900 MHz band.

NextNav admits it has not yet analyzed Part 15 uses of the Lower 900 MHz band to understand the impact of its proposal on the many hundreds of millions of embedded radios active today. Digi and its competitors make significant and increasing use of the band; it is a preferred unlicensed band for numerous industries and use cases. It is plain from the Petition however that NextNav's reconfiguration would be inconsistent with the continued ability of Part 15 radios deployed today to operate using 50-channel hopping spread spectrum techniques that allow for higher powered 1 watt radio operations. Repacking into a narrower 11 MHz band from 26 MHz would eliminate this important capability. And to the extent that the repacking occurred, there would be severe performance degradation of these radios due to the loss of bandwidth.

Moreover, NextNav requests that the FCC eviscerate a critical aspect of the Lower 900 MHz spectrum hierarchy that requires M-LMS licensees to test and evaluate interference potential to unlicensed radios. This is an established and critical element of co-existence in the band. Without it, NextNav could co-locate at cellular sites at will and operate at a power level that would overwhelm Part 15 radios or systems, creating unpredictable large coverage holes where there is coverage today.

The Public Notice sought cost-benefit information to better evaluate the reconfiguration proposal. Digi tried to model reasonable but very conservative assumptions about the scope of a transition and the associated costs required to update software or replace Part 15 radios in devices that would be necessary to effectuate reconfiguration that applied NextNav's proposal. Assuming there are approximately 294 million Part 15 radios that utilize this band in the U.S., Digi's preliminary estimate of the costs for just the Part 15 community to transition would be $27 billion, potentially running up to $33 billion dollars. Notably, at the end of this transition, these radios would lose 60% of their performance capability due to the loss of available bandwidth. Also, customers would face uncertainty as to whether a NextNav transmitter site could suddenly begin operation and render the reconfigured unlicensed radios inoperable without recourse. Some systems might not be able to function under these constraints. It should be plain that the costs to Part 15 users alone significantly exceed the public benefits of conferring deep competitive advantages on NextNav. The FCC should reject the Petition for Rulemaking.

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Comment in Opposition

Digi International Inc. ("Digi") files this Comment in opposition to the request by NextNav to initiate a rulemaking proceeding to reconfigure the Lower 900 MHz band and to modify or eliminate technical and operational rules so that NextNav can deploy a 5G terrestrial positioning, navigation and timing ("PNT") network with excess capacity for cellular carriers.[1] NextNav's premise that it alone can provide innovative complementary service to the existing U.S. Global Positioning System ("GPS") is false; there are many networks and systems under development; systems that would not disrupt the operations of the entire Lower 900 MHz band. NextNav's request is vast in scope and brazen in terms of its willingness to sacrifice the many millions of 900 MHz unlicensed devices and numerous critical uses they provide today simply to advance its business objectives.

I. Introduction.

Digi has been operating and producing unlicensed devices since 1985 and has been supplying Lower 900 MHz band radios to customers for nearly 25 years. Digi is one of many Part 15 radio providers who compete to facilitate customer solutions using many millions of unlicensed devices in various spectrum bands. Digi has an active, significant embedded base of 900 MHz radios in use and under development to serve its customers. For these customers it is essential that the Lower 900 MHz band remain accessible and useful during the full lifecycle of these radios, radios that are used by government and critical industries to collect and act on data to protect safety, property and advance environmental, commercial and other functions.

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[1] *See* NextNav Petition for Rulemaking, Enabling Next-Generation Terrestrial Positioning, Navigation, and Timing and 5G: A Plan for the Lower 900 MHz Band (902-928 MHz), Public Notice, WT Docket No. 24-240 (rel. Aug. 6, 2024) ("Public Notice").

There are several key advantages to customers from unlicensed radio operation in the Lower 900 MHz band that would be lost by adoption of the NextNav proposal. By its nature, the band provides the customer with better penetration than alternative bands. This has been particularly useful to customers with infrastructure in buildings. Renewable energy in particular has realized this benefit as the 900 MHz band allows consistent and reliable communications between charging stations in parking structures. Outdoor use of the 900 MHz band also allows for better propagation. This allows larger areas and systems to be connected with fewer hops and ultimately more bandwidth is available for the customer's use. There is an additional clear advantage in that the current 900 MHz rules allow for a higher-powered unlicensed radio. With the current band plan and FCC rules, up to 50 hopping channels can be configured allowing use of a full 1 Watt radio.[2]

For all these reasons, Digi is seeing an increase in popularity of use of the Lower 900 MHz band. And as end users experience crowding in the 2.4 GHz space with elevated noise floors and decreased link budgets, some customers are expressing the desire to move their operations to the 900 MHz spectrum as it offers users a highly reliable communications link under difficult environmental conditions.

Digi offers customers many radios that make use of the higher power opportunity at 900 MHz and its customers would be adversely affected by the NextNav proposal as those radios would no longer function for the reasons Digi explains below. NextNav has not yet done its research to understand the scope of existing unlicensed radio uses and the way they operate in the band but it is evident to Digi that NextNav's proposed reconfiguration is incompatible with unlicensed use of the Lower 900 MHz band. Given the critical capabilities and uses made by Part 15 users in the band, the scope of disruption and costs any reconfiguration and associated transition would have, the Federal Communications Commission ("FCC") should reject NextNav's Petition for Rulemaking.

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[2] FCC rule 47 C. F. R. §15.247 allows for unlicensed 900 MHz radios to employ higher powered (1 watt) channel hopping in unlicensed devices; however, in order to make use of that higher power limit, a radio must operate by hopping over 50 channels separated by at least the 20 dB bandwidth of the radio signal. Digi maximizes this signal bandwidth so that the radio can provide high data throughput.

II. Digi and others provide essential support for critical infrastructure nationwide that relies upon Part 15 radios operating in the Lower 900 MHz band.

The industries, applications and uses for unlicensed 900 MHz devices continue to expand. Digi is one of many 900 MHz radio device providers and the scope of uses its customers make of the Lower 900 MHz band demonstrates that the proposed reconfiguration would be catastrophic for many industries and applications. The embedded base of Digi's 900 MHz radios serves a wide range of industry verticals and customers, most notably in renewable energy (solar and wind), oil and gas, agriculture, smart city/street lighting, environmental monitoring, support for autonomous vehicles, drones and devices as well as general application remote monitoring and control functions. The applications for each sectors' use of unlicensed 900 MHz radios are discussed below.

Renewable Energy Use. This sector represents an important market for Digi in the 900 MHz band and it is popular based on the ability to have better range, larger networks, and faster bandwidth than in other bands where unlicensed use is permitted. Solar farms often cover large areas, making it challenging or cost prohibitive to connect equipment. 900 MHz radios enable wireless transmission of data from various components, such as inverters, solar panels, weather stations, and energy meters, to central monitoring systems. The 900 MHz band is well suited for solar farm remote monitoring because it can cover long distances with relatively low power, making it the efficient choice for solar-powered devices. The 900 MHz radios collect data on the performance of solar panels, including metrics like voltage, current, temperature, and power output and this data is transmitted to the central control unit for analysis and potential action.

Oil and Gas Sector Use. Digi historically has had customers in the oil and gas industry that use unlicensed wireless applications; they tend to intensively use Digi's XBee 900 MHz radios. There are abundant competitors to Digi that also use 900 MHz spectrum on an unlicensed basis to support this sector.[3] Cellular and wired connectivity very often does not reach remote oil fields which is why 900 MHz unlicensed radios are used to collect data and mesh network are then used to relay data to gateways that either have cellular connectivity or an internet connection.

Supervisory Control and Data Acquisition (SCADA) systems in oil and gas operations often rely on 900 MHz radios to transmit data between remote field sites (e.g., wellheads, pipelines, and compressor stations) and central control rooms. This allows operators to perform real time monitoring of control equipment remotely. 900 MHz radios transmit telemetry data such as pressure, temperature, flow rates, and valve positions from remote sensors to the SCADA system so that safe and efficient operations are safeguarded. These same radios are used to connect sensors along pipelines that detect leaks, pressure drops, or other anomalies. Data is wirelessly transmitted to central monitoring stations, enabling quick response as potential issues may arise. For corrosion prevention, cathodic protection systems often use 900 MHz radios to monitor the integrity of pipelines. The radios transmit data regarding the effectiveness of the protection system, assisting in ensuring the integrity and longevity of the infrastructure.

Around and within oil and gas facilities, 900 MHz radios also are used to transmit data from gas detection sensors that monitor for hazardous gases like methane or hydrogen sulfide.

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[3] These competitors include Freewave, GE MDS, Xetawave, Banner Engineering and Sierra Wireless, among others.

Immediate alerts can be sent to the control room if dangerous levels of harmful gases are detected. 900 MHz radios also are often used to remotely control and automate pumps, valves, and other equipment at wellheads. This is especially important in remote or hard-to-access locations where on-site or manual operation would be costly and time-consuming. Finally, data on oil and gas production rates, pressure levels, and equipment status at the wellhead can be wirelessly transmitted to central systems for analysis, allowing for optimized production and maintenance.

Agriculture Sector Use. Agriculture is another sector that Digi supports. 900 MHz radios are integral to modern agricultural practices, providing reliable, long-range communication for a wide range of applications, from precision farming and irrigation control to livestock management and greenhouse automation. These radios help improve efficiency, optimize resource use, and enhance overall farm management.

Precision Agriculture (PA) covers specific agriculture use cases and wireless connectivity, including use of 900 MHz unlicensed spectrum, a key component of PA. For example, sensors placed in fields measure soil moisture levels and transmit data using 900 MHz radios to a central system. This information allows farmers to make informed decisions about irrigation, optimizing water usage and improving crop yields. In precision farming, 900 MHz radios are used to control Variable Rate Technology (VRT) equipment, such as fertilizer spreaders or seed planters. The radios transmit data to adjust the application rate based on real-time field conditions, reducing waste and improving efficiency. 900 MHz radios enable the remote monitoring and control of irrigation systems. Data from weather stations, soil moisture sensors, and other field devices are sent via 900 MHz radios to a central controller, which can then automate irrigation schedules, ensuring optimal water use.

In large-scale farms with pivot irrigation systems, 900 MHz radios are used to monitor and control the movement and water flow of the pivots, ensuring uniform water distribution across the fields. 900 MHz radios also are used for animal management, with RFID tags attached to livestock. These tags transmit data about the animal's location, health status, and activity levels to central monitoring systems. This allows farmers to track and manage their herds more effectively. Tractors, combines, and other farm machinery also can be equipped with 900 MHz radios to monitor their operation, location, and maintenance status which assists in optimizing equipment use and scheduling maintenance. Finally, for greenhouse operations, 900 MHz radios are used to wirelessly control and monitor various environmental parameters, such as temperature, humidity, CO2 levels, and light. Automated systems adjust these conditions to optimize plant growth. Digi can share several examples of its customers' use of 900 MHz radios in this sector.[4]

Smart City/Street Lighting Application Uses. Digi's 900 MHz radios are used increasingly in streetlight applications as part of smart city initiatives to improve energy efficiency, reduce maintenance costs, and enhance public safety. Several examples of this include the use of 900 MHz radios to allow centralized monitoring of streetlights across a city or region. Each streetlight is equipped with a radio that communicates with a central management system, allowing operators to control remotely lighting schedules, intensity, and other settings. These radios can be programmed to turn lights on and off according to preset schedules, to align with sunrise and sunset times, or other specific requirements, reducing energy costs. These 900 MHz radios also transmit real-time data on the operational status of the lights, including any faults or failures. If a light goes out or a component malfunctions, the system automatically sends an alert to maintenance crews, enabling quick repairs. Data collected can be analyzed to predict when a light or its components (e.g., bulbs, drivers) are likely to fail. This allows for predictive, proactive maintenance, reducing downtime and costs.

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[4] *See* Jain Irrigation Provides Connected Solutions for Precision Agriculture and Smarter Landscaping
https://www.digi.com/resources/customer-stories/jain-irrigation-precision-agriculture-solutions;
Biofeeder Helps Shrimp Farmers to Automate Feeding Schedules
https://www.digi.com/resources/customer-stories/biofeeder-helps-shrimp-farmers-to-automate-feeding; Ranch Systems Leverages Digi XBee To Deliver Cloud-based Agriculture Automation
https://www.digi.com/resources/customer-stories/ranch-systems-digi-xbee-agriculture-automation
WiseConn Brings New Efficiencies to Agriculture with Precise Irrigation
https://www.digi.com/resources/customer-stories/wiseconn-brings-new-efficiencies-to-agriculture
Enabling Internet of Things Innovation in Agriculture
https://www.digi.com/resources/customer-stories/enabling-internet-of-things-innovation-in-agricult;
Dynamax SapIP Optimizes Health and Growth of Irrigation-Sensitive Crops
https://www.digi.com/resources/customer-stories/dynamax-sapip-agriculture-sensing-irrigation

Digi's 900 MHz radios play a crucial role in the development of smart, efficient, and responsive street lighting systems, a key element of smart cities. They provide reliable, long-range communication that enables remote monitoring, energy savings, adaptive lighting, and integration with broader smart city initiatives. These systems contribute to safer, more sustainable urban environments while reducing operational costs for municipalities.

Environmental Monitoring Uses. There are a wide range of environmental sensing and monitoring applications made possible at 900 MHz using unlicensed spectrum. For example, remote weather stations equipped with 900 MHz radios can monitor environmental conditions such as wind speed, temperature, and humidity, which are critical for operational safety and planning, particularly in offshore or remote onshore locations. 900 MHz radios are also used in barns or outdoor livestock areas to monitor environmental conditions such as temperature, humidity, and gas levels. This data helps ensure that the animals are kept in optimal conditions, improving their health and productivity. Streetlights can be equipped with environmental sensors (e.g., for air quality, temperature, humidity) that use 900 MHz radios to transmit data to central systems. This turns streetlights into multifunctional devices that contribute to broader environmental monitoring efforts.

Finally, airborne drones outfitted with environmental sensors (e.g., for air quality, temperature, radiation) use 900 MHz radios to transmit collected data to ground stations. This is particularly useful in remote areas where real-time data is critical for monitoring environmental conditions. Digi can provide several public examples of its customers use of 900 MHz radios in these markets.[5]

Autonomous Vehicle, Drone and Device Uses. Digi's customers use its XBee 900 MHz radios for autonomous vehicles and/or drone applications. 900 MHz radios are critical components in the operation and communication of autonomous vehicles and drones, enabling reliable, long-range data transmission for navigation, control, and coordination. For example, 900 MHz radios are used to establish command and control (C2) links between ground stations and autonomous vehicles or drones. This allows operators to send commands, such as changing course, adjusting speed, or initiating landing sequences, and to receive real-time feedback from the vehicle.

Drones and autonomous vehicles transmit real-time telemetry data (e.g., GPS location, speed, altitude, battery status, sensor readings) back to the control station via 900 MHz radios. This data is essential for monitoring the vehicle's status and ensuring safe operation. The 900 MHz frequency band is well-suited for long-range communication, making it ideal for BVLOS operations where the drone or vehicle operates beyond the visual line of sight of the operator. 900 MHz radios maintain a strong communication link over several kilometers, depending on environmental conditions and antenna setup.[6] Drones increasingly are being used for aerial surveying and crop monitoring and they often use 900 MHz radios to communicate with ground control stations. These drones can collect data on crop health, growth stages, and field conditions, which is then used to guide farm management practices. Digi can provide several public examples of its customers use of 900 MHz radios in this vertical.[7]

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[5] Digi XBee-Enabled Sensors Monitor Harsh Environments
https://www.digi.com/resources/customer-stories/xbee-enabled-sensors-monitor-harsh-environments;
National Control Devices Creates Efficient, Cost-Effective Sensor Networks with Digi XBee 900 MHz Connectivity
https://www.digi.com/resources/customer-stories/national-control-devices-efficient-sensor-networks

Remote Monitoring and Control Uses. Many of the uses for unlicensed 900 MHz radios discussed above involve a range of remote control and monitoring functions. These can be considered as a participation in the Internet of Things (IoT), Machine-to-machine (M2M) or SCADA systems. Regardless of the label, Digi's 900 MHz radios play a crucial role in enabling remote monitoring and control, providing a reliable, long-range communication solution that allows for real-time data transmission and control of critical systems, improving efficiency, safety, and operational effectiveness in various industries.

In Supervisory Control and Data Acquisition (SCADA) systems, 900 MHz radios transmit data between remote sensors, controllers, and a central monitoring station. These systems are used in industries such as oil and gas, water and wastewater treatment, and manufacturing to monitor and control equipment and processes from a central location. In M2M communications, 900 MHz radios enable wireless communication between machines, allowing them to operate autonomously or under remote supervision. For example, in manufacturing plants, robots or CNC machines can be controlled and monitored wirelessly, improving flexibility and reducing downtime. In large commercial buildings, 900 MHz radios are used to control and monitor Heating, Ventilation, and Air Conditioning (HVAC) systems. These radios enable remote adjustments to temperature settings, airflow, and system diagnostics, improving energy efficiency and occupant comfort.

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[6] 900 MHz radios are often used in conjunction with other communication systems and radio bands (e.g., 2.4 GHz, 5.8 GHz) to provide further reliability and redundancy. If one communication link fails, the 900 MHz radio can take over, ensuring continuous control and data transmission.

[7] Renu Robotics Helps Solar Energy Facilities Improve Vegetation Management with Autonomous Mowers https://www.digi.com/resources/customer-stories/renu-robotics-solar-fields-automated-mowers; Drone Technologies Disrupting Industries, Saving Lives https://www.digi.com/resources/customer-stories/draganfly; DreamQii raised over $1.1 million dollars with their crowdfunding campaign for the PlexiDrone https://www.digi.com/resources/customer-stories/dreamqii

Utilities also use 900 MHz radios to read meters remotely, whether for electricity, gas, or water. These radios transmit consumption data to central servers, allowing for automated billing and reducing the need for manual meter reading. In water and wastewater treatment facilities, 900 MHz radios are used to monitor and control remote pumps, valves, and other equipment. This allows operators to manage the system efficiently, even in geographically dispersed areas. Digi can share public examples of solar car projects where students are using Digi's 900 MHz radios for remote control and monitoring.[8]

In sum, industries critical to every facet of life and production in the U.S. make extensive use of 900 MHz unlicensed radios, whether these radios are provided by Digi or by others. New applications are constantly evolving, and Digi is launching new products in the Lower 900 MHz band this year and beyond. No credible case can be made that unlicensed Part 15 device use of this band is not intensive and the use cases not critically important to users and to the public at large. NextNav's Petition must be considered in the context of these critical uses and their public benefits.

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[8] Illini Solar Car Team Making the Future of Transportation a Reality
https://www.digi.com/resources/customer-stories/illini-solar-car-the-future-of-transportation
University of Minnesota Solar Vehicle Project Takes Top Honors, Helping Redefine Future of Electric Cars
https://www.digi.com/resources/customer-stories/university-of-minnesota-solar-vehicle-project

III. NextNav's proposal suits its unique spectrum holdings and advances its business interests, but it relies upon bald assertions; there are other paths to and potential providers of GPS alternative services.

Digi appreciates that the FCC's Wireless Telecommunications Bureau and Office of Engineering and Technology jointly posed a number of specific questions in the Public Notice that seek to identify the likely effects of NextNav's proposal not just on NextNav and its potential cellular provider partners, but on all users of the Lower 900 MHz band. Prior to embarking on the proposed rulemaking, this level of scrutiny is well warranted.

Despite acquiring extensive M-LMS license holdings in FCC spectrum auctions, NextNav has turned some licenses back in, has had some of its licenses terminated, has filed serial waivers for its geographic Economic Area ("EA") construction deadlines and has received FCC relief on many of these requests. NextNav plainly has struggled to deploy commercial services consistent with the rules the FCC established for M-LMS co-existence within the established spectrum usage rights hierarchy of the Lower 900 MHz band. NextNav now has identified yet another new opportunity to resuscitate its business plan and to make its 900 MHz licenses more valuable by offering "3D" terrestrial PNT for cellular E911 location, among other applications. This plan involves the modification of its licenses to expand their footprint by a spectrum swap and allow NextNav's reuse of significant excess spectrum capacity that it would then offer to its cellular partners.

NextNav acquired its M-LMS licenses knowing of the established "free service" economic model for GPS services and the spectrum usage rights hierarchy for the band that required consideration for Part 15 use. Presumably it had a business plan at the time that justified its investment decision and FCC spectrum auction rules require that auction applications acknowledge and certify they understand and will operate consistent with all FCC technical and operational rules applicable to their licenses. While NextNav now seeks to have the FCC sweep away the band plan and rules that impede NextNav's announced "vision" to provide terrestrial PNT, the changes required to effectuate this vision would be catastrophic or at the very least severely disruptive to other 900 MHz users as well as prohibitively expensive, as Digi explains below. The costs and adverse effects to other 900 MHz users far outweigh the purported benefits.

As a threshold matter, however, the Petition asserts that NextNav alone has the superior or only solution for providing alternatives to GPS, including other PNT technologies. That is simply not credible and cannot be the justification for the FCC to undertake the complex mission of rearranging the 900 MHz band plan, with the vast disruption of the relocations, technical relief and rule changes that NextNav seeks.

There are alternatives to NextNav's 900 MHz reconfiguration proposal, as the Public Notice itself highlighted. NextNav's proposal seems to have developed from its work in response to the U.S. Department of Transportation's ("DOT") initiative to identify emerging and future alternatives or complements to GPS. As reflected in its Petition for Rulemaking, NextNav was one of eleven companies that demonstrated potential alternatives to DOT, and while NextNav's technology relies on terrestrial PNT, there are others that make use of other modes of communication and other spectrum bands that offer advantages over NextNav's solution. While NextNav was awarded grant money by DOT for testing and further development, it was one of nine companies that got DOT grants for development and testing of PNT technology.[9] Notably, not one of these other alternatives would require the FCC to undertake a rulemaking to recalibrate nearly every aspect of operation in the Lower 900 MHz spectrum band today in a manner that significantly disrupts or ends the possibility of other uses and users.[10] NextNav has failed to make anything close to a compelling case that the federal government will lack access to viable GPS supplements or full scale alternatives without the FCC acting on NextNav's proposal. The FCC should reject the Petition on this basis alone.

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[9] *See* Public Notice at 3, fn 17, *U.S. Department of Transportation awards $7 Million for Complementary Positioning, Navigation and Timing Technologies,* (July 3, 2024); https://www.transportation.gov/briefing-room/department-transportation-awards-7-million-complementary-positioning-navigation-and.

[10] Several alternatives to GPS are listed in this article: U.S. Transportation Officials Seek Alternative Tech for GPS - IEEE Spectrum. Specifically, it notes that UrsaNav and Hellen Systems are based on

Moreover, NextNav has not shown that its PNT technology could not be implemented in another spectrum band where it would not be as disruptive to other critical spectrum users. NextNav's Petition states that it has cellular carrier partners, carriers that operate in a number of spectrum bands throughout the US. There is no reason why these partners could not make the limited amount of spectrum needed for NextNav's terrestrial PNT available on those networks and in their customer's devices to assist in better in-building E911 location services. It would appear however, that NextNav's proposal provides something of value to these carriers – access to a portion of Lower 900 MHz spectrum on commercial terms that NextNav fails to discuss in its Petition. The identification of only the Lower 900 MHz band for NextNav's proposed service demonstrates that NextNav seeks to craft a spectrum allocation and PNT service that would uniquely benefit NextNav - and potentially its cellular partners.

There are countervailing considerations for the FCC to analyze. NextNav's proposal comes weighed with very heavy baggage in that NextNav's desired reconfiguration would result in NextNav "swapping" spectrum to hold a 15 MHz single nationwide license that it would allow its cellular partners to use as well. The FCC seeks comment on the scope of "the windfall that NextNav might receive as a result of its proposed spectrum swap for a new nationwide license, including the acquisition of accompanying rights as a licensee and lessor, the application of flexible use and less

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e-Loran for their location solutions, Echo Ridge's solution uses existing Globalstar satellites, OPNT is a timing solution that uses existing terrestrial fiber optic communication infrastructure and has no reliance on GPS, PhasorLab solution offers PNT services through a Hyper Synchronized Wireless Mobile Mesh Communication Network, Satelles uses Iridium satellites which transmit at 1000 times the power of GPS, and finally, Serco, Seven Solutions Sociedad Limitada, Skyhook Holdings-acquired by Qualcomm and TRX Systems all have alternate solutions.

restrictive technical rules to this band and how the Commission should address any such windfall."[11]

Putting aside for the moment both the flawed premise that might justify considering a spectrum swap and the vast collateral damage to other 900 MHz users that would be caused by adoption of the proposal, the FCC is correct in identifying issues with the unwarranted windfall to NextNav that would result from adoption of its proposal. The FCC would essentially be playing kingmaker by awarding NextNav a terrestrial PNT monopoly as it is unlikely other technologies could easily overcome the advantages conferred by a free nationwide 15 MHz license and regulatory relief from protecting the operations of critical Part 15 uses. The proposal represents a spectrum grab at the expense of all other communities of interest that currently use the band for their operations. It is even more outrageous because NextNav seeks to repurpose much more spectrum than it needs to provide terrestrial PNT services. NextNav envisions it would offer this excess spectrum to cellular providers for their use. This presumably would provide NextNav with yet another revenue source to more deeply establish its dominance over other forms of PNT or quasi-PNT deployments that could become viable alternatives or supplements to GPS without the vast collateral damage to other uses of the 900 MHz band.

The federal government has every reason to plan for the future for its location, logistics and positioning needs, identify options to fit these needs and encourage the type of competitive creativity that can lead to superior market-based solutions. It would represent poor public policy to declare NextNav the PNT technology winner now, when there are numerous other options for GPS alternatives available or under development, as is plain from the fact that the Department of Transportation awarded eight other PNT development grants along with the award to NextNav. This is particularly true as NextNev is not remotely ready to deploy; it first requires the FCC to put its thumb on the scales to effectuate a full band reconfiguration before it could begin to deliver on its vision. Any band reconfiguration would be time consuming, costly, complex and the FCC and other Lower 900 MHz stakeholders would have to grapple with a range of serious technical issues presented by the proposal. Governmental interests and the public interest would be better served by continuing to encourage the development of competing GPS complementary solutions that do not require upending the Lower 900 MHz band plan, the application of special treatment and a stunning regulatory windfall for only one would-be PNT provider.

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[11] Public Notice at 6.

IV. NextNav has no plan for co-existence in the Lower 900 MHz band; it has failed to inventory actual use or to account for the devastating effects of its proposal on Part 15 users.

The Public Notice reiterates that the Lower 900 MHz band plan has operated on a basis of a hierarchy of spectrum usage rights, one that notably from the outset of establishment of LMS service rules, required M-LMS licensees to perform testing to ensure some level of interference protection for unlicensed operations.[12] As NextNav seeks to eliminate this testing protection for Part 15 devices, the FCC understandably seeks to know how that, combined with the proposed band reconfiguration, would affect the many millions of unlicensed devices operating today in the Lower 900 MHz band.

NextNav attempts to downplay the disruption of its proposal to other 900 MHz users by stating in its Petition that it will accept responsibility to protect licenses that already have superior interference protection rights.[13] As to Part 15 unlicensed radios, as the Public Notice states, NextNav has not completed its technical analyses of the impact of its plan, but instead offers to

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[12] *See* LMS Operations in the 902-928 Band, 47 C.F.R. § 90.353.

[13] NextNav also offers to work with non-LMS incumbents and pay for their retuning or relocation, although no details are provided as to how that process would work.

"work with unlicensed users to understand their spectrum requirements." [14] This offer of future cooperation is meaningless given NextNav's proposed annihilation of FCC rules that are crucial to enable Part 15 device co-existence within the band. NextNav's failure to engage with Part 15 stakeholders earlier or perform due diligence to ensure there are not fundamental threshold challenges with its proposal strongly suggests that NextNav is not focused on balancing other stakeholder interests and instead seeks to skate by with mere promises to do future work to assess the effects. Much more should be expected from the proponent of such a sweeping and disruptive plan.

If NextNav had performed any serious technical analysis to understand Part 15 spectrum requirements at 900 MHz, it would not have presented the proposal it did. A glaring problem with NextNav acquiring 15 MHz of the Lower 900 MHz band is that it would appear to require unlicensed operations to repack into the remaining 11 MHz, [15] which in and of itself would be a logistical challenge of major proportions as unlicensed devices are not in the control of Part 15 device manufacturers, but rather are in the hands of users, including government and critical industries and that may have a 20 year or more lifecycle before needing replacement.

But the bigger issue is that Digi and other radio providers have made use of the FCC's allowance in Lower 900 MHz for higher powered (1 watt) Part 15 radios by employing 50 channel spectrum hopping techniques.[16] The amount of usable spectrum remaining once NextNav has its single nationwide 15 MHz license cannot accommodate a 50-channel spread spectrum hopping bandwidth while maintaining current infrastructure data rates. Critically, there is a direct relationship between data throughput and bandwidth; the bandwidth of a channel is maximized so the data throughput can be maximized. Under existing FCC rules, the channels would have to be roughly 40% their current width to fit within an 11 MHz band.[17] Digi's current 900 MHz radios have channels that are 500 kHz apart and as a result they would not fit in this smaller portion of the band. In fact, assuming away for the moment the monumental logistical and commercial challenges of dealing with the embedded base of higher-powered radios, the performance of new radios redesigned to "fit" in an 11 MHz versus 26 MHz band would be significantly degraded. Digi estimates that the maximum throughput would drop to 40% on a radio required to use this narrower bandwidth and channel spacing.

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[14] Petition at 31.

[15] 900 MHz spectrum available for unlicensed use under NextNav's proposal would drop from 26 MHz to about 11 MHz.

[16] FCC rule 47 C.F.R. §15.247 allows higher powered unlicensed devices in the band so long as they employ frequency hopping techniques spread over a larger portion of the band than the 11 MHz NextNav would leave for other's use.

Leaving aside the gating issue of technical infeasibility of the proposed band reconfiguration for accommodating higher powered channel hopping spread spectrum Part 15 devices, NextNav has also proposed the elimination of the rule requiring that it demonstrate through field tests that its systems do not cause unacceptable levels of interference to Part 15 devices. This is not a minor point. If adopted, the proposal would modify operational rules to the point that Part 15 radios could not, as a practical matter, continue to operate. There would be no ability to co-exist. Specifically, the co-location of high powered NextNav facilities with cellular sites, or NextNav transmitters elsewhere, coupled with the loss of the FCC rule to test to show protection of Part 15 operations, would create sudden, immediate large coverage holes for unlicensed radios, radios that are operating well in today's environment. In that scenario, users would be faced with uncertainty regarding loss of coverage and would have no recourse for that loss.

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[17] In order to comply with the current 50-channel requirement, the channel bandwidth cannot be greater than 500 kHz because 25 MHz divided by 50 channels = 500 kHz leaving 500 kHz on each side of the 26 MHz spectrum band. This determines the maximum data rate of simple modulation techniques like FSK or QPSK that provide the lowest current solutions and longest range. Lowering the available spectrum to 11 MHz from 26 MHz would require radios to change their channel bandwidth from 500 kHz to about 211 to maintain 50 channels. This would reduce the data rate to less than half of what it was before at about 42% of the current speeds offered. Slower data rates reduce battery life as well as push up congestion and latency, because the radio must turn on its transmitter for longer to get the same information through. The chance of transmission collisions also goes up, which is an exponential problem, not a linear one. More radios need to compete for the same transmit time. If FCC rules were changed to allow for less channels and keep the same data rate, running less channels still impacts the number of collisions that can occur on different networks because a 1/50 chance changes to 1/20.

Over the years since it won its LMS licenses at auction, the FCC has provided NextNav with numerous opportunities to update its plans to take advantage of technical advances and to assist cellular carriers in their ability to provide in-building location services. But NextNav's latest plan would sacrifice all Part 15 use of the Lower 900 MHz band, use that the FCC has repeatedly acknowledged as wide and varied public, private and consumer uses that include smart grids, remote monitoring and many other important functions.[18] NextNav offers no compelling reason to the FCC to upend the successful co-existence and well-functioning spectrum rights hierarchy that has been the hallmark of the band and the FCC should decline NextNav's invitation.

V. The billions of dollars of costs to Part 15 device users and the public if the NextNav proposal were to be implemented far outweigh any asserted public benefit.

The Public Notice seeks comment on the costs and benefits to public and to the Part 15 community should the FCC advance NextNav's proposal. As noted above, the proposal precludes any continued reasonable use of existing Part 15 devices in the Lower 900 MHz band both because they cannot not operate as before within an 11MHz portion of the band that would remain and because NextNav would no longer have to consider or test for the effects of its revamped operations on Part 15 devices.

Critically important remote sensing, smart grid and other operations would cease. There would be no short or painless transition as the Part 15 radio lifecycle is long and many embedded radios and devices are not able to be updated over the air. Digi formulated and modeled what it believes to be very conservative estimates of the numbers and types of radios and devices that utilize the Lower 900 MHz band today and consider over the course of a years' long transition period what it could collectively cost for Part 15 radios to be software updated or replaced so as to operate within the NextNav band plan. This model also assumes that updated radios would meet all existing operational use case requirements despite losing 60% of their performance capability due to the loss of available bandwidth.

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[18] *See* Progeny 2011 Waiver Order, 26 FCC Rcd 16878 (2011) at paragraph 29.

Digi chose a conservative estimate of the number of industrial IoT, agriculture, oil and gas, renewables, smart city and other applications in radios that may use 900 MHz in the US today of approximately 294 million radios in the aggregate.[19] The actual number could be higher and the model would yield higher costs. If one assumes a five-year transition period for reconfiguration, it is reasonable to expect that about 35% of the radios can have software updated remotely using over the air (OTA) programming. Another approximately 55% of the radios may be consolidated within a device or do not have OTA capability and would require on-site, manual updating. A third category of about 10% would be radios that are simply unable to be software updated that would have to be replaced.

While there are a number of variables that could affect the results, Digi estimates that the costs for developing, validating, certifying, and supporting deployment of updated radio software (firmware) for the approximately 294,000,000 radios would be about $2.72 per radio.[20] The estimated cost for the software update investment would be $800 million. While some portion of the radios could be updated using OTA, there would need to be significant project management, coordination, truck rolls and dedicated technician time to visit sites to update the approximately 55% of radios that are not OTA capable, as well as an estimated 10% that would need to be replaced. Digi estimates that about 29,400,000 radios would need to be replaced at a cost of $250 approximately for each new device with an embedded radio or over $7.3 billion in replacement hardware costs alone. For these replacement radios and the remaining estimated 55% of radios that would have to be updated in the field, Digi estimates that effort as one hour per radio per technician with an average hourly rate of $100 for this onsite work. There would be administrative and project management costs as well. This field work alone represents over $19 billion in costs.

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[19] There are a number of variables Digi used to reach this estimate, and Digi acknowledges that device age and condition, the technological complexity of updating software, the geographic distribution of devices, the availability of qualified technicians, the compliance timeframe, the consideration of economies of scale and the unknowns of supply chain potential of disruption, and perhaps other variables all could affect estimates and their end results. Nevertheless, it is still important that the FCC be aware of the general magnitude of the task if the NextNav plan were to proceed.

[20] Digi's estimate of $2.72 per-device as a baseline was modeled is assuming costs of $400,000 for development/ test/certification/support for four devices each for 500 global vendors, across all devices.

This preliminary modeling estimate for Part 15 radio reconfiguration comes in at about $27 billion dollars, but that figure does not consider what could be considerable R&D costs to develop new compatible systems, lost productivity during the transition, potential loss of critical services and infrastructure during a transition, training of technicians and end users, accelerated depreciation of existing equipment, the potential need for multiple iterations of updates and most importantly, the operational impacts to thousands and thousands of unlicensed radio users of the loss of 60% of the Lower 900 MHz bandwidth available. These types of additional considerations suggest that a range of $27 to $33 billion is a reasonable, conservative preliminary estimate of the costs to the Part 15 community of a Lower 900 MHz reconfiguration to accommodate NextNav's business interests.

Critically, after these enormous costs are incurred and radios updated or replaced, they would not function as well as they do today under the existing band plan and with protection considerations that NextNav seeks to strip away. There would be no guarantee some radio systems

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would function nearly as well as they do today; certain higher-powered radios and systems would have to undergo redesign and some uses might simply no longer be feasible. These costs cannot be quantified but the potential for total disruption of some systems is quite real.

There are governmental, critical industry and consumer interests that have invested in and rely on unlicensed operations in the Lower 900 MHz band and these interests should not be ignored or assumed away. The inherent characteristics of and rules for 900 MHz higher powered operations make the band fairly unique as a home for some radio applications that could not readily be accommodated in other bands where unlicensed use is permitted. The costs to the government and the public of a transition within or out of the 900 MHz band far outweigh the benefit to NextNav and its would-be cellular carrier partners, particularly as there are other potential providers of the services NextNav seeks to offer.

VI. Conclusion

For all the reasons Digi has stated, the public interest would not be served by the FCC issuing a Notice of Proposed Rulemaking on NextNav's proposal. The proposal is justified on bald assertions that NextNav would be the only or best provider of GPS complementary service; that is plainly not accurate.

NextNav's failure to assess the effects of its proposal on existing Part 15 radios and devices means that its Petition has not accounted for the 50-channel hopping, higher powered unlicensed radios operating today; these cannot be repacked into a smaller portion of the band with, at best, severe degradation in performance. Moreover, NextNav has not made any case for the FCC eliminating a key requirement of the Lower 900 MHz spectrum hierarchy of rights, that of pre-deployment testing to ensure unlicensed operations have some protection from interference. Maintenance of this testing and assessment protocol is critical to Part 15 users in the band. Finally, the preliminary estimated costs of reconfiguring the US base of unlicensed radios that utilize the band is well in excess of $27 billion up to $33 billion and the resulting updated/replaced radios would not function as well as they do today with less bandwidth. They also would be subject to unexpected and complete coverage loss if NextNav is not required to protect them.

In sum, the NextNav Petition seeks a spectrum windfall for NextNav at the expense of other critically important uses of the Lower 900 MHz band. Its Petition only scratches the surface in terms of the many unexplored costs and glaring technical challenges that would have to be addressed. The proposal also has grave public policy downsides and the FCC should reject NextNav's Petition.

Respectfully submitted,

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September 5, 2024